FORMATION AND SOURCES OF THE SHALBATANA VALLEY SYSTEM. **A. Palmero[1], S. Sasaki[1], R.O. Kuzmin[2] and R.Greeley[3].** [1]*Department of Earth and Planetary Science, University of Tokyo, 7-3-1 Hongo, Bunkyo-ku Tokyo 113-0033, Japan (Alexis@space.eps.s.u-tokyo.ac.jp, sho@eps.s.u-tokyo.ac.jp)* [2]*Vernadsky Institute of Russian Academy of Sciences, Kosygin Str. 19. Moscow 119991, Russia (rok@geokhi.ru)* [3] *Department of Geological Sciences Arizona State University, Box 871404, Tempe AZ 85287-1404 (Greeley@asu.edu).*

Introduction: A large concentration of seemingly collapsed features and associated outflow channels are found between western Lunae Planum and western Arabia Terra in the cratered highlands (units Npl1 and Npl2 [1]) and the volcanic plains (unit Hr [1]). Comparisons with terrestrial flood channels, such as those of Channeled Scablands in eastern Washington, suggest that the Martian channels were eroded by catastrophic floods [2,3,4]. Most of the Martian channels originate from chaotic terrains interpreted to represent areas where the ground collapsed as water (confined under the permafrost) was released under high hydrostatic pressures within artesian basins [5,6]. Understanding the geologic history of the Shalbatana Valley System (SVS) can improve our knowledge of groundwater recharging and extraction mechanisms, and the derivation of the history of valley formation in the highlands. Shalbatana Vallis was interpreted as an outflow channel excavated by water flow from an ice-covered paleolake in Ganges Chasma [7] and from catastrophically releases from confined aquifers as the permafrost seal [8] was disrupted at three locations, forming chaotic regions [9]. Palmero and others [10] proposed that the excavation of SVS also involved water released from an extensive underground cavern system. They also proposed an alternative hypothesis for the origin for the Shalbatana upstream chaotic region; they suggest that a highly degraded late Hesperian impact crater (SE part) collapsed over the putative cavernous system. In this work, we have used 128 pixels/degree MOLA DEMs to derive alternative hypotheses for the origin the Basin-A and its chaotic material, as well as for the origin of the flanking Valley system III (Fig.1).

The Basin A: The abrupt widening of the main Shalbatana Valley occurs at the junction between VS-I and B-A (Fig.2). This is also the transition of the main valley from incision into the Noachian plateau (bounded by unit Npl2 to the east) and to the West by VSIII (Hesperian highland unit Hr). The chaotic terrain in B-A was used as evidence that this basin resulted from collapse over an aquifer [9]. The east margin of the main SVS valley shows a change in orientation where it bounds B-A, which resemble intercepted craters. The topographic region TL1 partly bounds the basin at an elevation of about 700 meters above TL2 and TL3 (Fig.2). A channel (Chn) extends from VSI into B-A, the margins of which are partly bounded by TL1-A and TL1-B. This suggests that the topography was continuous prior to channel formation. The topographic and roughness characteristics of these terrains resemble those of Crater A (Fig.2 and Fig.3). Moreover, unit TL1-C occurs along the flanks of the arcuate cliff section. These observations are consistent with this unit representing the floor of collapsed craters intercepted by SVS. The karst-like features (seen on the top edges of B-A [11]), are consistent with collapse processes for this part of the valley. Structural control [9] over the main valley determined the deep and narrow U-shaped VSI, which is incised into the Noachian highlands. Structural control along the eastern flank of the main valley is suggested by the orientation, depth and slope characteristics and we propose that the abrupt widening of the main valley resulted from a change in lithologies. This hypothesis is consistent with the distribution of the chaotic terrain, which is rougher, more abundant, and topographically higher on the flanks of VSIII. This suggests that the chaotic material was shed from the VSIII upland. The position of the deepest and smoothest topographic unit (TL3) is consistent with its being a depositional area for material carried by the channel (Chn). We propose that flow from VS-I intercepted a series of collapsed craters in this region and possibly formed a crater-lake system, which might have extended as far as the end of VS-II. The geological materials composing the western margin of this lake system were apparently volatile rich.

The VSIII complex: It has been proposed [9] that water from the B-A region successively drained and excavated the d1 and d2 channels in the Hesperian plateau (Fig.3). These two channels were abandoned following the deepening of the main channel towards the Simud valleys [9]. We have observed that this region forms a complex system of valleys, which includes rimless quasi-circular depressions, elongate depressions, pit chains and deep U-shaped valleys. The roughness of this region reveals a high frequency, low amplitude component, which would be consistent with extensive thermokarstic activity and other subsurface degradation processes [10,11].

The d2 system. The contact between the d2 system and B-A forms a wide valley (Fig.3, yellow dotted line), which narrows and is incised by a relatively narrow, south-dipping central region (d2a). Channel d2a joins with d2b to the north, forming a deep U-shaped valley. B-A drainage by the d1 and d2 channel systems is consistent with the temporal ponding of VS-1, B-A and VS-II, which was subsequently lowered as flow toward the Simud valley occurred [11]. We propose that in a first stage flow took place from B-A to the north, forming a drainage channel of which only the northern d2b section remains. After drainage from B-A ceased the northern margin of B-A became unstable and recession occurred preferentially headward along the preexisting drainage channel. Recession happened mainly as debris flows, fed by material shed from the valley flanks to its central region, flowed towards B-A, which resulted in valley widening, excavation of the central channel d2a, and the deposition of most of the chaotic unit TL2.

The d1 system. This system forms an N-trending series of depressions, which includes wide shallow regions (Fig.3, WSR), narrow enclosed-and elongate-regions (Fig.3, NEER), and deep, rimless quasicircular depressions (Fig.3, RQCD). This association does not seem to be the result of surface flow and it is more consistent with subsidence related to long-lasted subsurface degradation, possibly by water flowing through underground conduits [10]. Other features in the region consistent with large subsurface processes include the floor of Crater A, which shows surface modifications and an elongate depression that extends south from the margin of crater A, forming a sequence of pits, which shallow up and become narrower to finally disappear near the margin of the VS II.

Final remarks: These regions of the SVS demonstrate the importance of lithological and structural controls over the morphological characteristics of highland valleys. Our observations suggest that processes possibly related to debris flows and thermokarstic degradation produced the knobby material in the chaotic region within B-A. The observing evidence for extensive underground denudation apparently had resulted in different degrees of subsidence, which might have been related to the development of cavernous systems. These issues are important to understand the complexity of hydrological processes involved in the formation of the SVS, to quantify the amount of water involved, and the amount of material eroded during its excavation.

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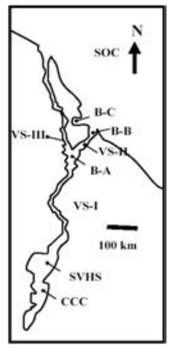

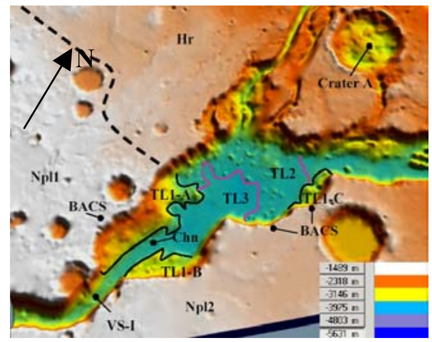

Figure 1. (upper left*) Feature map. CCC: Collapsed Conduit Complex, SVHS: Shalbatana Valley Headwater System, VS-I to III: Valley systems I to III, B-A to C: Basins A to C, SOC: Simud Outflow Channel.*
Figure 2. (upper right) *MOLA DEM of B-A. Crater A is 35 km across. Npl1, Npl2: Noachian plains 1 and 2. Hr: Hesperian ridges. BACS: Bounded arcuate cliff sections, TL 1-3: Topographic levels 1 to 3.*

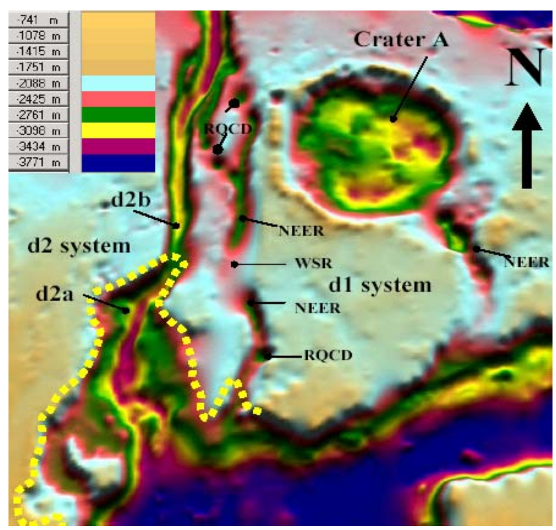

Figure 3. *MOLA DEM of VS-III. Crater A is 35 km in diameter. The d1 system includes RQCD: Round quasicircular depressions, NEER: Narrow enclosed elongate depressions, WSR: Wide shallow region. The d2 system includes channels d2a and d2b.*